WHAT IS CLAIMED IS:

1. A magnetoresistive element comprising:

a substrate; and

a multi-layer film formed on the substrate,

the multi-layer film comprising a pair of ferromagnetic layers and a non-magnetic layer sandwiched between the pair of ferromagnetic layers,

wherein a resistance value depends on a relative angle formed by magnetization directions of the pair of ferromagnetic layers, and

wherein when a centerline is defined so as to divide the non-magnetic layer into equal parts in a thickness direction, the longest distance from the centerline to interfaces between the pair of ferromagnetic layers and the non-magnetic layer is not more than 20 nm,

where the longest distance is determined by defining ten centerlines, each of which has a length of 50 nm, measuring distances from the ten centerlines to the interfaces so as to find the longest distance for each of the ten centerlines, taking eight values except for the maximum and the minimum values from the ten longest distances, and calculating an average of the eight values.

2. The magnetoresistive element according to claim 1, wherein the substrate is a single-crystal substrate.

3. The magnetoresistive element according to claim 1, wherein the non-magnetic layer is a tunnel insulating layer.

4. The magnetoresistive element according to claim 1, the multi-layer film further comprises a pair of electrodes that are arranged so as to sandwich the pair of ferromagnetic layers.

5. The magnetoresistive element according to claim 1, wherein the longest distance is not more than 3 nm.

6. The magnetoresistive element according to claim 1, wherein a composition in a range that extends by 2 nm from at least one of the interfaces in a direction opposite to the non-magnetic layer is expressed by

$$(Fe_xCo_yNi_z)_pM^1_qM^2_rM^3_sA_t$$

where M^1 is at least one element selected from the group consisting of Tc, Re, Ru, Os, Rh, Ir, Pd, Pt, Cu, Ag and Au, M^2 is at least one element selected from the group consisting of Mn and Cr, M^3 is at least one element selected from the group consisting of Ti, Zr, Hf, V, Nb, Ta, Mo, W, Al, Si, Ga, Ge, In and Sn, A is at least one element selected from the group consisting of B, C, N, O, P and S, and x, y, z, p, q, r, s, and t satisfy the following equations:

$0 \leq x \leq 100$,
$0 \leq y \leq 100$,
$0 \leq z \leq 100$,
$x + y + z = 100$,
$40 \leq p \leq 99.7$,
$0.3 \leq q \leq 60$,
$0 \leq r \leq 20$,
$0 \leq s \leq 30$,
$0 \leq t \leq 20$, and
$p + q + r + s + t = 100$.

7. The magnetoresistive element according to claim 6, wherein p, q, and r satisfy $p + q + r = 100$.

8. The magnetoresistive element according to claim 7, wherein p and q satisfy $p + q = 100$.

9. The magnetoresistive element according to claim 1, wherein the multi-layer film further comprises an antiferromagnetic layer.

10. The magnetoresistive element according to claim 9, wherein a distance between the non-magnetic layer and the antiferromagnetic layer is 3 nm to 50 nm.

11. A magnetoresistive element comprising:

a substrate; and

a multi-layer film formed on the substrate,

the multi-layer film comprising a pair of ferromagnetic layers and a non-magnetic layer sandwiched between the pair of ferromagnetic layers,

wherein a resistance value depends on a relative angle formed by magnetization directions of the pair of ferromagnetic layers,and

wherein a composition in a range that extends by 2 nm from at least one of interfaces between the pair of ferromagnetic layers and the non-magnetic layer in a direction opposite to the non-magnetic layer is expressed by

$$(Fe_xCo_yNi_z)_pM^1{}_qM^2{}_rM^3{}_sA_t$$

where M^1 is at least one element selected from the group consisting of Tc, Re, Ru, Os, Rh, Ir, Pd, Pt, Cu, Ag and Au, M^2 is at least one element selected from the group consisting of Mn and Cr, M^3 is at least one element selected from the group consisting of Ti, Zr, Hf, V, Nb, Ta, Mo, W, Al, Si, Ga, Ge, In and Sn, A is at least one element selected from the group consisting of B, C, N, O, P and S, and x, y, z, p, q, r, s, and t satisfy the following equations:

$0 \leq x \leq 100$,
$0 \leq y \leq 100$,
$0 \leq z \leq 100$,
$x + y + z = 100$,
$40 \leq p \leq 99.7$,
$0.3 \leq q \leq 60$,
$0 \leq r \leq 20$,
$0 \leq s \leq 30$,
$0 \leq t \leq 20$, and
$p + q + r + s + t = 100$.

12. A method for manufacturing a magnetoresistive element,

the magnetoresistive element comprising a substrate and a multi-layer film formed on the substrate, the multi-layer film comprising a pair of ferromagnetic layers and a non-magnetic layer sandwiched between the pair of ferromagnetic layers, wherein a resistance value depends on a relative angle formed by magnetization directions of the pair of ferromagnetic layers,

the method comprising:

forming a part of the multi-layer film other than the ferromagnetic layers and the non-magnetic layer on the substrate as an underlying film;

heat-treating the underlying film at 400°C or more;

decreasing roughness of a surface of the underlying film by irradiating the surface with an ion beam;

forming the remaining part of the multi-layer film including the ferromagnetic layers and the non-magnetic layer on the surface; and

heat-treating the substrate and the multi-layer film at 330°C or more.

13. The method according to claim 12, wherein the surface of the underlying film is irradiated with the ion beam so that an angle of incidence of the ion beam at the surface is 5° to 25°.

14. The method according to claim 12, wherein a lower electrode and an upper electrode are formed as a portion of the multi-layer film, and the lower electrode is included in the underlying film.